COLLABORATIVE CONSUMPTION: PROFITS, CONSUMER BENEFITS, AND ENVIRONMENTAL IMPACTS

BY

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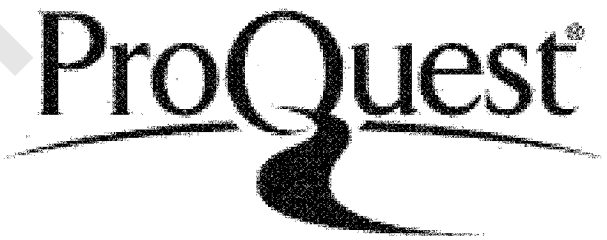

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

Symbol	Definition
Chapter 2 and 3	
q	intrinsic design quality of the product
θ_h	marginal WTP of consumers in the high-end segment
θ_l	marginal WTP of consumers in the low-end segment
γ	proportion of consumers in the low-end segment
n	average size of sharing groups
t	inconvenience cost in sharing
Chapter 4	
n	size of sharing groups
γ	congestion effect parameter in sharing
α	probability of joining small groups
d	size difference between large and small groups
m	number of types of correlated groups
β	marginal impact of production to the environment
k	coefficient of marginal impact of consumption to the environment

ABSTRACT

With increasingly connected consumers and technological advancement, peer-to-peer sharing is emerging as a consumer-led initiative, which is aimed to exploit slack capacities and lower the cost of consuming private goods. Sharing is praised for its potential benefits of improving consumer access, consumer surplus, and environmental impact. On the other hand, sharing may possess credible threats to producers because of cannibalization and reduced sales quantity. This thesis is composed of three papers on the subject of peer-to-peer sharing of durable goods, e.g., cars, bikes, gadgets, and household appliances.

The first paper studies pricing and product design decisions of a single-product monopolist in a market. We identify the conditions under which a firm would accommodate or hinder peer-to-peer sharing by pricing the product appropriately. We find that the firm's profit can be enhanced only when the consumer valuation heterogeneity is neither too high nor too low, and the product's intrinsic value is sufficiently high. In addition, contrary to the conventional wisdom, we show that sharing does not always improve consumer access to products. Furthermore, some consumers may end up being worse off. Finally, we find that social sharing may enhance or impede product innovation, depending on consumer heterogeneity and the size of sharing groups.

In the second paper, we study whether social sharing will encourage or discourage product differentiation. We find that the two ways of expanding the market, one consumer-initiated and one firm-initiated, can be strategic complements or substitutes, depending on consumer heterogeneity, group size, product intrinsic value, and cost structure. We characterize such conditions. For example, we show that accommodating sharing provides the firm a higher incentive to introduce a differentiated product when the product intrinsic value and consumer heterogeneity are both low,

or are both high. We also extend the study by allowing consumers to endogenously choose their sharing group size, and show that it may enhance or worsen the firm's profit.

The third paper focuses on the environmental impact stemming from production and consumption, in the presence of peer-to-peer sharing. The product usage of sharing consumers is modeled as a function of capacity congestion and group size. We show that a "danger" zone exists where sharing is profitable for the firm but is not friendly to the environment. When the firm has an influence on the sharing group size (e.g., by promoting sharing programs in metropolitan areas or college towns), the economic incentive and environmental impact can be aligned. Specifically, we find that stronger congestion effects may induce the producer to promote sharing in larger groups, which in turn results in a more positive environmental impact. Such situations are more likely to occur when the product unit cost is large. Moreover, we characterize conditions under which the firm may prefer heterogeneous networks composed of groups with different sizes or social networks with lower homophily, and meanwhile the environmental impact can be improved.

CHAPTER 1
INTRODUCTION

> "...technology has reduced transaction costs, making sharing assets cheaper and easier than ever–and therefore possible on a much larger scale. The big change is the availability of more data about people and things, which allows physical assets to be disaggregated and consumed as services."
>
> —*The Economist* 2013 [Eco13b]

Supported by the widespread use of the Internet, virtual social networks, and mobile technology, we see a recent increase in peer-to-peer social sharing groups that make it possible for people to share their privately owned goods with friends, neighbors, and even strangers. "Smartphones with GPS let people see where the nearest rentable car is parked; social networks provide a way to check up on people and build trust; and online payment systems handle the billing. What's mine is yours, for a fee."(*The Economist* 2013)[1]. The goods being shared are typically products such as cars, power tools, snowblowers, garden equipment, and solar panels, that are widely owned by people who do not make full use of them.[2] Peer-to-peer sharing provides a mechanism to exploit the existing slack capacities in those goods, which are categorized by Benkler as "mid-grained lumpy type" [Ben04] [3]. For such products, the

[1]For example, car owners who rent their vehicles to others using Relayrides make an average of $250 a month [Eco13b].

[2]RelayRides, Getaround, Wheelz, and Buzzcar, are the programs in which car owners can grant others access to their vehicles. NeighboorGoods, Share Some Sugar, and Sharetribe are the groups for products like gadgets, household items and tools. Mosaic is an example of sharing program in solar panels.

[3]The way those groups conduct the sharing activities has an in-between

combination of infrequent usage and with high costs creates a heavy burden of sole ownership [GS10]. People are becoming more practical and efficient in consumption, such that easy access to products is preferred over ownership [BR10, BE12]. In addition, some noble souls genuinely believe that sharing can reduce the environmental impact of consumption [BR10, Tru03]. The size of the sharing market is no longer trivial. For example, car sharing in North America alone is expected to reach $3.3 billion in 2016 (as quoted in Sacks [Sac11]), and the consumer peer-to-peer rental market is estimated to be worth $26 billion [BR10].

Many rental service providers [4] describe their services as "sharing," despite their similarity to traditional rental service. The use of the term "sharing" embodies the idea of transforming the habit of wasting unutilized resources into collaborative consumption [BR10]. Accordingly, a sharing program is designed to replace one's need to own a certain good. For example, the traditional car rental service may be appropriate for tourists or businessmen who occasionally travel away from home. However, this type of service would not be suitable for people who regularly need cars for short errands in their locality. A typical car-sharing program offers some unique features that better fit the needs of these individuals. For instance, shared cars are typically located within walking distance, the rental process is made swift and easy, the car can be borrowed at any time of the day or night, and the minimum rental period is calculated on an hourly basis or even less. With this type of service configuration, it is expected that consumers may well forgo private car ownership. While a peer-to-peer sharing service is based on the principles of collaborative consumption and elimination of the need for ownership, there are special characteristics that make this type of service distinct from others, as described below.

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characteristic of sharing within family and commodity exchanges, as prototyped in Belk [Bel10].

[4]For examples Zipcar and Car2Go.

First, shared products belong to the consumers themselves, unlike traditional rental services where the rental firms typically own their products. Owners purchase the products in the regular market, and then made them available to be shared or co-owned with others. The products used in peer-to-peer sharing are identical to those bought by people who acquire them solely for personal use, whereas there often are special purchasing arrangements between rental firms and product manufacturers.

Second, owners purchase the products based on their own individual preferences and are solely responsible for the products' maintenance. There are no standardized specifications for the products; neither is there an enforced quality assurance procedure. This differs from traditional rental services, wherein products tend to be standardized and regularly inspected for possible problems. Consequently, peer-to-peer sharing may have more variants of products compared to rental services, and, as a result, there may be greater vulnerability to quality-related problems. Furthermore, unlike in rental services, if a problem occurs it is not easy for a user in peer-to-peer sharing to find a replacement for a specific product. Owners also must themselves deal with problems concerning their goods and any decrease in their value, although they may nonetheless have insurance coverage for major accidents. Thus, peer-to-peer sharing may not be attractive to people who are highly concerned with product quality.

Third, the availability of goods in peer-to-peer sharing is not guaranteed, primarily because owners occasionally use their own products. Furthermore, no mechanism currently exists to balance the number of users with the number of products in service. This differs from rental services, wherein the ratio between products and potential consumers is one of the main concerns of service providers. Thus, the scarcity risk, i.e., the likelihood that a product will be unavailable when needed, is more intense in peer-to-peer sharing. The scarcity risk level is affected by several factors.

For example, frequently used products such as cell phones tend to have a higher level of scarcity risk than those used less frequently, such as lawn mowers. The procedures implemented and types of technology applied in sharing groups also influence the scarcity risk level, e.g., an online-based booking system would increase the probablity of being able to access a specific product when and where needed. The level of scarcity risk also depends on the number of people who wish to consume a good or partake of a service, i.e., higher group size creates higher risk.

Fourth, users in peer-to-peer sharing borrow the products directly from individual users without an intermediary. Owners' main motivation to share their goods is typically either to lower the cost of ownership or simply to obtain additional revenue. Therefore, owners are more willing to charge lower fees than are rental firms. Understandably, low cost is considered by users as the main attractive benefit of peer-to-peer sharing [JHH98, LR12, LS12], unlike rental services providers whose aim is to maximize their profits.

Fifth, reputation within the social networks, external and internal, is important in peer-to-peer sharing. Owners frequently find information about potential users , and users find information about owners and their products from social networking. Moreover, both parties normally post comments about their lending-borrowing experiences on social networks after each transaction, unlike traditional rental services, where credibility is assessed through formal channels.

Other inconveniences may also exist in peer-to-peer sharing. For example, a car-sharing user might need to allocate extra time to find its exact location, the owner's personal touch inside the vehicle may make the user feel uncomfortable, and it may be difficult to find an empty parking spot when returning the car. Thus, sharing may not be preferable for people who highly value convenience.

The existence of peer-to-peer sharing with its unique characteristics creates opportunities and challenges for producers. If a significant part of the market chooses to share instead of own, then a considerable decline in sales quantity should be warranted. The existence of sharing consumers may also cannibalize producers' existing markets, or at least shrink the potential demand for the products. This is particularly true when producers cannot differentiate between consumers who purchased for self-ownership and those who prefer sharing. In this situation, producers are unable to apply a product differentiation strategy, or special supply chain contracts to the service providers, as is commonly conducted in the rental industry. On the other hand, with peer-to-peer sharing, consumers who individually cannot afford to buy a product can collectively purchase it as a group. Thus, sharing provides a way for producers to obtain an additional source of profit. Producers may also increase prices if the total valuation of members within sharing groups is significantly high. These competing impacts of sharing may allow producers to gain in certain situations, and lose in others. Producers might also be incentivized to undertake certain actions that may in turn either benefit or harm consumers. Besides, producers may be capable of influencing regulatory agencies to prohibit the act of sharing. For example, as mentioned in The Economist [Eco13a] and Forbes [Ger13], in some cities, peer-to-peer car services have been banned after lobbying by rental companies, claiming the lack of tax rules for individual renters. As argued in Triplepundit [Sie13], as the sharing economy keeps growing, we may see some indignant manufacturer lobbying for a new law that allows an agreement accompanying a purchase (i.e., copyright) that forbids sharing.

People praise sharing for its promising impacts on consumers and the environment [BR10]. Without sharing, financial constraints may preclude some consumers from using certain goods. With sharing, the cost of consumption can be lowered, such that people in the bottom of the pyramid can still access these products. Meanwhile,

the benefit to the environment is expected to come from a lower number of products sold in the market. However, the anticipated advantages of sharing would depend on producers' actions. Hence, the eventual impact of sharing may not be obvious.

The objective of this study is to provide insights on the impact of peer-to-peer sharing on producers, consumers and on the environment. We focus on two salient features of durable goods, i.e., quality deterioration and non copy-ability. Attention to product quality is important because of the frequent usage and the lack of maintenance procedures in peer-to-peer sharing. Meanwhile, the non copy-ability characteristic of durable goods and the lack of a balanced ratio between consumers and products may worsen the scarcity risk of products in sharing. We formulate the study into three separate papers, each addressing certain market situations and exploring certain aspects of peer-to-peer sharing.

The first paper studies pricing and product design decisions of a single-product monopolist in a market. We identify the conditions under which a firm would accommodate or hinder peer-to-peer sharing by pricing the product appropriately. We find that the firm's profit can be enhanced only when the consumer valuation heterogeneity is neither too high nor too low, and the product's intrinsic value is sufficiently high. In addition, contrary to the conventional wisdom, we show that sharing does not always improve consumer access to products. Furthermore, some consumers may end up being worse off. Finally, we find that social sharing may enhance or impede product innovation, depending on consumer heterogeneity and the size of sharing groups.

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CHAPTER 2

PEER TO PEER SHARING: PRODUCT PRICING AND DESIGN

2.1 Preface

The emergence of peer-to-peer sharing provides a way for consumers to lower the cost of consumption and increase the ability to purchase a product by aggregating their willingness to pay. This, in turn, presents opportunities and threats for product manufacturers. An increase in willingness-to-pay may result in an additional number of sales coming from an otherwise unserved market. A higher profit margin may also be obtained if the purchasing power of sharing groups is significantly high. On the other hand, the existing market maybe cannibalized because of the inability of producers to differentiate between consumers who purchase the products for sole ownership or for sharing purposes. Collaborative consumption would also shrink total demand for the products. Thus, accommodating sharing may be beneficial in certain situations but not in others. Producers can accommodate sharing or persuade consumers to individually own a product by charging an appropriate price. for example, a sufficiently low price may make consumers prefer to own even if sharing is possible.

Price may not be the only decision that needs to be considered. Frequent usage and inconveniences inherent in the sharing of durable goods would lower the quality of products from their designed levels. Thus, sharing may also be accommodated or hindered by increasing or decreasing the product quality levels , a decision that may subsequently increase or decrease the firm's profit.

Sharing is a consumer-led initiative, with the goal of making consumers economically and environmentally better off. However, manufacturers' decisions on product pricing and quality would determine whether an effort to introduce sharing can actually be realized. Those decisions would also affect consumers' ability to access

the products, the level of quality received, and the level of surplus obtained. It would indeed be ironic if sharing instead made consumers worse off.

In this paper, we study how a firm would manage its pricing strategy in the presence of consumer sharing. We answer the following questions: 1) When does a firm choose to accommodate or hinder consumer sharing? What roles do market characteristics (valuation heterogeneity and proportion of the sharing segment), product type (quality level and inconvenience cost), and sharing attribute (group size) play? 2) Can the existence of consumer sharing improve a firm's profit, and when? 3) Do consumers always have better access to a product with an option to share? 4) How does sharing impact consumer surplus? Will consumers always be better off with sharing? 5) Will sharing incentivize or impede product innovation? 6) How do the general results change with the ways in which sharing groups are formed (exogenous vs. endogenous group size)?

We assume a monopolist who sell a single type of product to a market consisting of two segments that differ in willingness-to-pay for quality and tolerance toward inconvenience. Consumers in the high-end segment are assumed to have a higher willingness-to-pay for quality but a lower tolerance to inconvenience in sharing (money rich time poor), such that they would never share. Consumers in the low-end segment are assumed to have a lower willingness-to-pay for quality but a higher tolerance to inconvenience in sharing, such that an option to share is eagerly welcomed. We focus on durable goods, where quality tends to deteriorate faster with sharing. Some of the main insights are summarized below.

We find that sharing is more likely to be accommodated by a producer if the product has a high quality level and if the valuation heterogeneity between consumers in the two segments is neither high nor low. There also exists a subset within that region, wherein the existence of sharing improves the firm's profit, compared to a

market without sharing consumers. If the valuation heterogeneity is high, the firm will not accommodate sharing, but will instead focus on selling to the high-end segment. Meanwhile, if the valuation heterogeneity is low and the product quality is not sufficiently high, then it is more profitable for the firm to persuade individual consumers in both segments to own the product by significantly lowering the price. In the latter case, the existence of sharing always lowers the firm's profit. Thus, the firm may be tempted to find other ways to hinder sharing, for example, by offering a similar service managed by its affiliate, or by lobbying the regulatory agencies to prohibit sharing.

The size of sharing groups plays an interesting role. If the size is small enough such that the willingness-to-pay of a sharing group is still lower than that of a consumer in the high-end segment, then an increase in the sharing group size always increases the profit from accommodating sharing, and makes it possible to accommodate the sharing of products with a lower quality level. This also makes it possible to accommodate sharing in a market where valuation heterogeneity is high. Meanwhile, if the size is sufficiently large, such that the willingness-to-pay of a sharing group is higher than that of a consumer in the high-end segment, then an increase in the sharing group size always decreases the profitability of accommodating sharing, because the market-shrinking effect of sharing dominates. Moreover, the profit obtained from selling to individual consumers in both segments will also decrease. Thus, the firm may have an incentive to persuade the regulatory agencies to set rules that will restrict the size of sharing groups, or to prohibit the act entirely.

From the consumers' point of view, we find that a minimum threshold of quality exists for products to be viable for sharing, such that the impact of inconvenience is insignificant. The lowest threshold value of quality can be reached if the size of sharing groups is determined based on maximizing consumer utility in sharing, i.e.,

endogenous group size. We also show that, contrary to conventional wisdom, sharing does not always improve consumer access. For products with an intermediate quality level, the existence of sharing would actually decrease the likelihood for low-end consumers to access the goods. This unfavorable situation always exists, even if consumers share in groups with endogenous size. With respect to consumer surplus, we show that the existence of sharing makes it possible for low-end consumers to gain a positive surplus. On the other hand, high-end consumers may end up being worse off, compared to a no-sharing situation. In addition, we find that sharing may enhance or impede product innovation, such that consumers may receive products with a higher or lower quality level, as compared to a no-sharing situation.

We discover that sharing can play the role of either a value creator or a value distributor. The former takes place if sharing is the only means for consumers in the low-end segment to access the goods. The new value that is obtained from the otherwise untapped market will flow as an additional profit to the firm and as surplus for consumers. Meanwhile, if sharing is introduced in the condition whereby all consumers can afford to purchase the product individually, then its existence creates a redistribution of value, such that either the firm or the high-end consumers would be worse off.

2.2 Literature Study

Belk argued that there are several reasons why people would hesitate to share, for example, if the goods are considered extensions of the individuals themselves, are considered scarce, or if ownership instead of the product itself is considered the major source of utility [Bel07]. Lamberton and Rose proposed a way to classify sharing systems, based on the levels of rivalry and of exclusivity within the service. Most sharing programs available today belong to a class called "open commercial sharing systems." The level of exclusivity in this category is low, and almost anyone

can join the service. The level of rivalry is high, such that people have to take turn to use the goods [LR12]. Their study also identified some major drivers of sharing propensity. Lower consumption cost is considered the main attraction of sharing services. Meanwhile, the propensity to join a sharing program would decrease if people perceive that the scarcity risk in sharing is high, or if owning and sharing are seen as two different things. This study suggested that scarcity risk depends on users' utilization levels and the existence of a control mechanism for allocation of access to products between consumers. A study on car-sharing services also reveals several attributes that play important roles in a consumer's decision to join the service, i.e., rental fees, availability, booking period, opening hours, and location [JHH98]. Specific to peer-to-peer sharing, quality-related issues such as damage, malfunction, or impurity in the goods seem also to be concerns of both owners and users [LS12].

These studies generally point out that low cost is the main benefit of sharing expected by consumers. We adopt this finding within our model, such that sharing would make the average price of the product paid by an individual member lower than that of sole ownership. The studies also indicate that characteristics inherent in sharing lower consumer willingness-to-pay for the shared goods. We incorporate this notion by introducing an inconvenience cost of sharing within our model, the magnitude of which determines whether consumers would or would not consider sharing. Two types of inconvenience tend to differentiate peer-to-peer sharing from rental services, i.e., product scarcity and product quality. Unlike a rental service, there is no clear effort to maintain an optimum ratio between the number of shared goods and potential users in peer-to-peer sharing. In addition, no maintenance or quality inspection activities are enforced in the service. Product quality would also be of concern to owners, because potential damage and rate of deterioration typically increase with frequent use. Since one of our objectives is to study the impact of sharing on product design, we set the inconvenience cost as a parameter that would subtract product